

**A Work Project presented as part of the requirements for the Award of a
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**Increasing supply chain visibility through information flow development:
A case study with Diehl Controls**

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List of Abbreviations:

DC: Diehl Controls

DCW: Diehl Controls Wangen

DCP: Diehl Controls Poland

DMAIC: define, measure, analyze, improve, control

MM: Max Müller

PUW0: buffer stock between Production and Dispatch (SAP)

SCM: Supply Chain Management

SIPOC: supplier, input, process, output, customer

VLM: Dispatch warehouse Müller (SAP)

VOC: Voice of the customer

1. Introduction

Diehl AKO Stiftung & Co. KG, founded in 1902, is an international company operating globally. It consists of five divisions (see Appendix 1), including Diehl Controls (DC). DC is one of the global leading suppliers in the domestic appliance industry by providing household device controls, modules, and systems, among others. With its headquarter in Wangen im Allgäu, Germany, Diehl Controls has seven subsidiaries in five countries – Germany, Poland, USA, Mexico, China – and employs around 3.200 people. Its annual sales are estimated to amount to €450 million in 2015. Some of its customers are global players like Bosch and Siemens. This thesis will focus on Diehl Controls Wangen, where currently around 500 employees work.

A supply chain management approach was taken when reorganizing all departments directly connected to the material flow in 2014. This decision provided the basis for an extensive redesign of the value stream. The approach's aim is both the elimination of inefficiencies as well as increased flexibility. Consequently, customer satisfaction is expected to increase through a higher service level. This objective is growing in importance since an internal workshop held in 2014 recognized supply chain efficiency and flexibility as the most important success factors. Due to the organizational structure of DC, the current order-to-payment process involves many different departments. The problem DC faces and which is aimed to be solved within this work is that the company lacks process efficiency and transparency, along with great challenges in terms of communication and coordination within the company¹. As a consequence, DC is not flexible when it comes to changing customer requests on short notice. Since those problems are often rooted in weak points in the information flow, supply chain visibility is aimed to be increased.

¹ A process is “a set of logically related tasks performed to achieve a defined business outcome” (Davenport/Short, 1990).

In a new project the information flow is now meant to be analyzed in order to prevent the above mentioned difficulties. Hence, visibility at weak points is meant to be increased through better communication, information transfer, and other approaches. The aim is to make the required information available at the right time at the right place in the right quality for the right person. By doing so, DC will continue to be the first choice for its customers and to continuously strengthen customer ties.

The following figure presents an overview of the overall approach taken in this work:

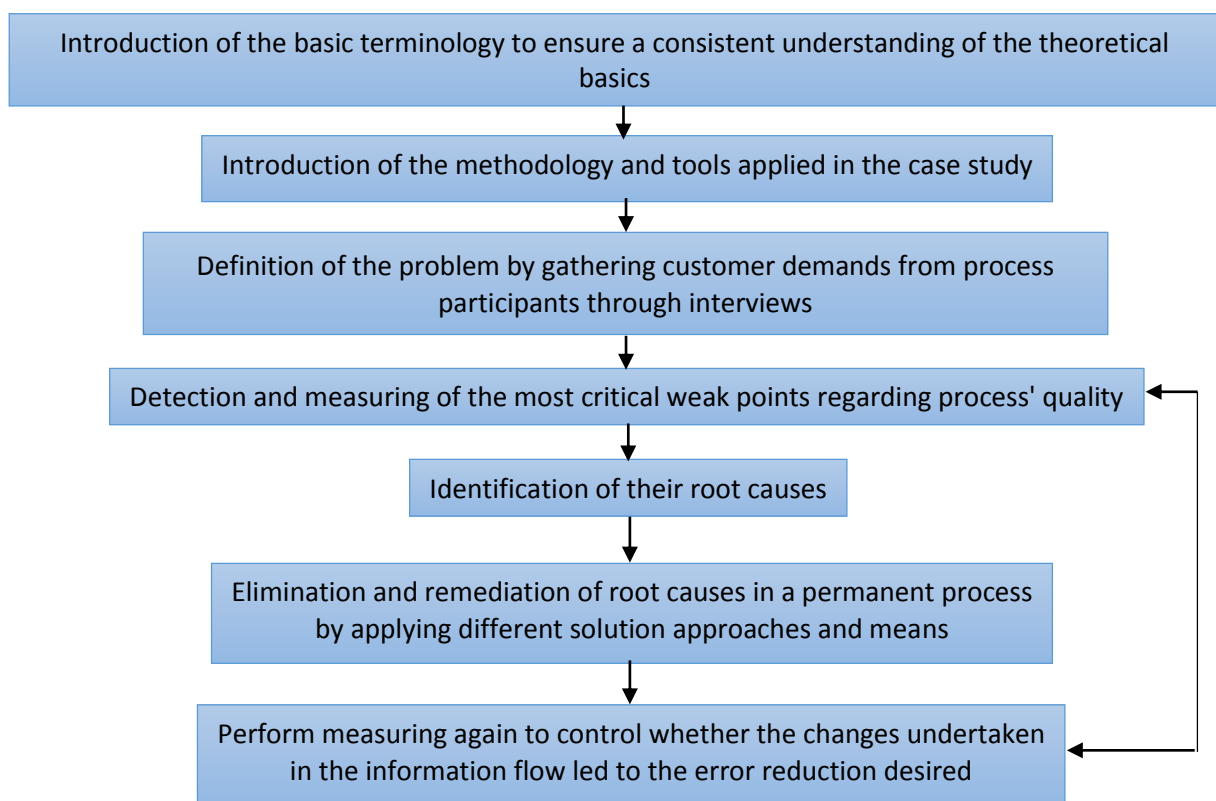


Figure 1: Approach of the work

2. Theoretical Background

2.1. Supply Chain Management

The concept of supply chain management² (SCM) arose at the beginning of the 1980's in the United States of America. From the mid- 90's onwards, the topic was dealt with from a theoretical perspective (Koch, 2012: 245). So far, no uniform definition has emerged. However, the

² Even though many studies focus on the external supply chain the majority of implications also apply for the internal supply chain. Thus, the findings of several authors can be interpreted as being valid for the external as well as internal supply chain. In the end, one cannot exist without the other.

basic meaning is clear: The focus is not on one individual company (external supply chain) or department (internal supply chain) anymore. It is heading towards a network-oriented point of view of several companies and departments, respectively. (Holcomb et al., 2011: 32)

SCM is concerned with increasing flexibility and efficiency of companies to guarantee customer satisfaction, while simultaneously reducing costs and ensuring a high level of quality (Becker, 2008: 45). As mentioned, there are several perspectives on SCM. One of them, which considers both internal and external supply chains, will be discussed in the following:

Supply chain management (SCM) is the oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. Supply chain management involves coordinating and integrating these flows both within and among companies. (Rouse, 2010: 1)

Rouse underlines the importance of a universal consideration of all flows – material-, information-, and financial flows. Those flows go beyond one single company/department and thus allow for an overview of the whole value chain from raw material procurement to the final consumer. The same accounts for the internal supply chain, where different departments are involved in providing a finished product (Basnet, 2013: 153). However, the customer may not be the final consumer. According to Porter's value chain model, these departments are called "primary activities", since they are directly related to the material flow thus representing the company's key process by adding value to the finished product, as shown in Appendix 2 (Porter, 1985: 151). As Chibba and Rudquist (2004: 5) put it, if all processes are connected and looked at as a whole across departmental boundaries, the term supply chain may be applied. This became increasingly important over the last couple of years, since an integrated supply chain is by now recognized as a critical factor to ensure company success (n.A.: n.Y a). Integration means that different parties work closely together by making relevant information available on time (n.A., n.Y. b). Due to growing competition on the back of globalization it is of major importance for companies to closely cooperate and communicate with suppliers and customers (Microsoft 2006: 17). Thus, a competitive advantage can be built by benefiting from synergy

effects, e.g. by reducing the so-called bullwhip-effect³. In SCM-studies the terms “coordination” and “communication” are frequently recurring when talking about a successful supply chain integration. By taking a holistic view on the value chain, there are many interfaces that need to be managed correctly in order to be more flexible and efficient than competitors. An interface represents a knot, where the information flow as well as the material flow often halts and becomes inefficient. Overcoming these interruptions is one of the main challenges SCM faces (Becker, 2008: 47).

2.2. Information Flow

As explained in the previous chapter, the success of implementing the SCM-approach is highly based on communication, meaning the transfer and exchange of information. Yet in 1985, Porter realized that efficient communication in the value chain can create a competitive advantage (Porter, 1985: 149 ff.). According to Durugbo (2013), the information flow in companies draws growing attention: “This is because a widely recognised challenge for organisations is how to better understand and manage processes for capturing, storing and retrieving information.” (Durugbo et al., 2013: 598). Information can be exchanged both by providing data via an operating system like SAP or by directly addressing a person (personally, phone, e-mail). The latter becomes especially important in cases of urgency and deviations from processes.

The focus on the cross-departmental information flow is essential, since it influences the efficiency within a company to a large extent: When it comes to discrepancies and uncertainties in the information flow, additional effort and inefficiencies occur in the material flow (Berger, 2003: 9). The purpose of information flows is planning, steering and controlling material flows,

³ Coordination and communication in the supply chain contribute to avoiding the bullwhip-effect and thus creating advantages like cost savings through reduced storage requirements (Lee, 1997: 52). The Bullwhip-effect is a phenomenon which is related to changing customer wishes and resulting forecasting planning. The further away a supplier is from the final consumer the higher variances between planned and actual material requirements are, even though demand only fluctuates negligibly. The consequence is high storage costs due to safety stocks at each stage of the supply chain (Koch, 2012: 247 ff).

highlighting the strong link between them (Koch, 2012: 31). Thus, the aim is providing the right information at the right time at the right place in the right quality (Chibba/Rundquist, 2004: 1). The connection between both flows surfaces when looking at processes and value streams: Both terms imply a parallel consideration of the two flows. However, until today, the focus is mainly on improving the material flow, neglecting the information- and financial flow's role.

Interfaces exist both internally between process steps and departments as well as externally on supplier's and customer's side. Often this is where the process is delayed and thus time is wasted and information can get lost (Becker, 2008: 271). Clear interfaces lead to clear processes and to a better definition of responsibilities (Schrottke et al., 2014: 3). Berger (2003) shares the other authors' opinion: He claims that especially the widespread departmental thinking⁴ leads to organizational interruptions in material- and information flows (Berger, 2003: 9). By analyzing the information flow, process steps with unnecessary interfaces and bottlenecks can be detected and resolved, which, as a consequence, improves the material flow as well.

2.3. Supply Chain Visibility⁵

The terms transparency and information are closely linked: While transparency describes a condition of clear structures and processes, information and communication constitute the medium of how to create and maintain this condition (Hofmann, 2007: 9). Hence, visibility can be defined as the amount of useful information shared across the supply chain (Holcomb, 2011: 33) as well as the pace in which a company manages to collect all data and information required to make relevant decisions (n.A., n.Y. b).

Several reports and case studies underline the importance of visibility in the supply chain: A survey carried out by the Aberdeen Group in 2013, for example, states that by putting a strategic focus on supply chain visibility, costs as well as service level can be optimized. Out of 149

⁴ The term departmental thinking describes the fact that employees are often exclusively familiar with the processes and structures of their own department and thus lack a holistic understanding of how processes are interconnected.

⁵ In the literature visibility and transparency are used synonymously since both are concerned with making relevant data and information readily available at the right place for the right person.

companies that have been questioned, 63% indicate that a transparent supply chain is considered a high priority. Among those, 44% see cross-departmental visibility and integration as their paramount strategic goal. Doing so, leaders (the best performing 20% of the companies) were able to deliver 96% of their finished products on time and complete to customers. On the opposite, followers only accomplished 89%. (Heany, 2013: 1 ff.) A survey carried out by Deloitte supports those findings. Leaders distinguish themselves by a higher transparency within the supply chain and indicate internal integration as very important (Deloitte, 2014: 6 ff).

There are additional benefits arising from transparency, thereby contributing to reduce costs and increase service level. Transparency helps identifying possible problems, “if the information is appropriately managed, monitored, and, above all, used” (Linich, 2014: 9). Bottlenecks and uncertainties can be recognized and therefore countered early before they lead to serious consequences, such as line standstills due to missing material (Tata, 2015: 3). By basing one’s decision-making-process on accurate information received on time, risk can be reduced to a large extent (Holcomb 2011: 34).

In order to receive the information needed and to act on this information on time, relevant data has to be provided via operating systems in addition to personal communication.

Clearly defined structures and processes lead to increased motivation as well (Hofmann, 2007: 13). Hence, it is safe to assume that demotivation is likely to occur when information is not provided automatically and employees have to spend valuable time to search and wait for certain information. Additionally, by only providing the right information, over-information can be avoided leading to a more efficient way of working since employees can focus on relevant issues (Tauber, 2013). Often it depends of the foresight of employees if the right information is provided at the right time. Only if one understands the consequences of missing information and data for downstream processes, transparency can be obtained. Even when information is automatically provided via operating systems, someone is responsible to enter

the data – be it manually, by scanning barcodes etc. – and hence an understanding of how this data is further processed by colleagues is needed. To create this understanding, Basnet (2013) recommends “job rotation, knowledge of each other, (...)” (Basnet, 2013: 155). The active involvement of employees in an improvement process that directly affects them can lead to significant performance improvements within the company (Berger, 2003: 10).

Consequently, if DC focuses on a more transparent information flow, the company will be able to solve its main problem, which is becoming more efficient and flexible towards customer requests, thus increasing customer satisfaction. Moreover, DC can take advantage of the benefits listed so far. DC might be able to significantly increase its delivery performance according to the Aberdeen Group’s survey, which currently is at 91%. A higher delivery performance has a positive impact on the company’s financial perspective as well (see Appendix 5).

3. Methodological Approach

Eisenhardt claims that the case study approach is “especially appropriate in new topic areas” (Eisenhardt, 1989: 532). While case studies can be used for both theory-testing as well as theory-building, this work focuses on the former approach (Eisenhardt, 1989: 536). Thus, the case study used here serves the purpose of examining if a more efficient and flexible supply chain can be generated by increasing its visibility, as stated by the literature above. The approach applied in the present case study is the DMAIC framework, which is an integral part of six sigma. Six sigma has proven successful in improvement projects by aiming to reduce defects, eliminate non-value-adding activities, and due to its overall customer orientation (Mehrerjerdi, 2011: 79 ff.). Herein, a “process’s client is not necessarily a company’s client” (Hammer/Champy, 1993: 50): Customers can be external as well as internal, that is to say process participants. DMAIC-projects comprise five interconnected phases: define, measure, analyze, improve and control the problem of interest. An overview of the aim of each phase is given in Appendix 6. There are several tools for each phase, which can be applied in accordance with

the objective of the project (Günther/Garzinsky 2009: 125). In the following, due to constraints of space only tools, which have been used for the case study, will be explained.⁶

Define-Phase: First of all, a project charter is created, which gives detailed information about background, scope, timeframe, objectives, benefits, responsibilities, and milestones of the project (Töpfer/Günther, 2009: 78). With conducting a voice of the customer (VOC)-analysis⁷, valuable insights into customer requests can be won, thus guaranteeing the effectiveness of the project by identifying problems that are critical to customer satisfaction (Mehrjerdi, 2011: 85). After gathering customer's statements, they can be neatly presented and categorized according to the main criticisms. The SIPOC (supplier, input, process, output, customer)-diagram is a visual tool that helps plotting the end-to-end process by showing relations between process steps and the associated departments. Thus, it builds the basis for the information flow analysis: It helps visualising the weak points mentioned by customers during the VOC-analysis, remove redundant process steps and understand communication barriers (Durugbo, 2013: 598). When graphically plotting the information flow, different approaches can be considered, depending on its purpose. While Becker (2008) focuses on a process-oriented point of view (flow chart, swim lane diagram etc.), Berger (2003) highlights the advantages of the information flow model. The former puts an emphasis on the sequence of process steps, whereas the latter focuses on the interconnections between the departments involved. Furthermore, the information flow model triggers the critical questioning among process participants regarding certain steps and the usefulness of connections. (Berger, 2003: 12)

Measure-Phase: On the basis of the VOC-analysis, the process steps, which have the most significant influence on the process and its quality, are tackled. These show the greatest deviation regarding customer expectation, which is why they have to be solved (Becker, 2008:

⁶ While all tools can be used to either analyze the material flow or information flow, the focus will be set on the benefits for information flow analysis.

⁷ The purpose of a VOC-analysis is ensuring the effectiveness of a project. It is based on gathering requests and complaints of customers regarding the current process. Consequently, the project can be executed accordingly.

59). The problems most critical to quality are converted into measurable variables. This implies that the process is measured to see how it currently performs in terms of defects, cycle time etc. (Rever, n.a.: 3). Then, a target value is agreed on according to the SMART⁸ criteria, depending on the current status. It helps defining if the project met the expectations and was successful.

Analyze-Phase: The fishbone diagram represents a robust method to systematically capture and structure the causes of problems. Thus, the cause-effect relationship can be portrayed concisely. Often, the main influential variables are divided into people, management, equipment, material, process, and environment. Consequently, causes are analyzed until, eventually, the root cause can be identified. (Brüggemann et al., 2012: 23). This results in a diagram similar to a fishbone.

Improve-Phase: After having identified the root cause, a brainstorming can be helpful to find creative approaches on how to tackle them. Consequently, the approaches are implemented.

Control-Phase: The final step of a project is measuring process steps against the solution approaches that have been implemented. Thus, the effectiveness of the solutions can be evaluated according to the target value agreed on in the measure-phase. (Rever, n.a.: 4). All improvements aim at increasing supply chain visibility and hence increase process' efficiency and flexibility. Regarding data collection a distinction between primary and secondary data has to be undertaken. While primary data is collected for a current project, secondary data exists already and was collected in a different context. Thus, the focus of the data might be different, which can lead to a lower data quality. (Arnold/Furmans, 2009: 238). For this project, mainly primary data such as semi-structured interviews was used to gather the information needed. Thereby, high quality of the data was assured and tailored to the project. Semi-structured interviews offer the possibility of letting the interviewed person structure the answers as preferred and putting his/her own focus within a certain frame given by the interviewer (Lamnek/Krell, 2010: 307). It can be ensured that all relevant topics are covered profoundly. A drawback of this method is

⁸ The target value has to be specific, measurable, attainable, realistic, and time-related

that the interviewer can be biased. Therefore, it is best if a neutral person executes the interviews. Additionally, it is possible that interviewers misinterpret statements. (Becker, 2008: 114)

4. Realization of the Project: A case study with Diehl Controls

The supply chain of Diehl Controls in Wangen (DCW) includes the following departments considered in the presented case study: Purchase Disposition, Goods Receipt, Incoming Inspection, Production Supply, Production Planning, Dispatch, and Sales Disposition. Furthermore, DC's logistics service provider Max Müller (MM) will be included, due to the close collaboration. Normally, forwarders deliver raw materials and collect finished goods at MM's storage facility⁹. A shuttle commutes between DCW and MM three times a day, delivering raw materials just in time and picking up finished products. As suggested by Mehrjedi (see p. 7) the project was conducted in close consultation with process participants to ensure that the improvements were effective and of relevance to them.

4.1. Define-Phase

The information contained in the project charter are mainly listed in the introduction and in Appendix 11. Only the following aspects will be considered: communication in series production and with Diehl Controls Poland (DCP), information available in IT-systems, departments relevant for the supply chain, and the development of transactions in SAP. The inclusion of external suppliers (except MM) and the communication for new product launches are out of scope.

To gain a comprehensive picture of the prevailing situation a VOC-analysis was carried out by conducting 19 semi-structured interviews with process participants. With the interviewer being new to the company, neutrality towards the interpretation of the statements was ensured. Thus, a total of 68 different statements regarding customer requests and consequently weak points in

⁹ MM is located in Opfenbach, which is approximately 10 km from DCW.

the information flow could be gathered (see Appendix 14). These statements illustrate where missing information or information overload as well as push information prevent employees from working more efficiently. The statements were divided into five categories. The number in brackets indicates the quantity of statements that were assigned to each category:

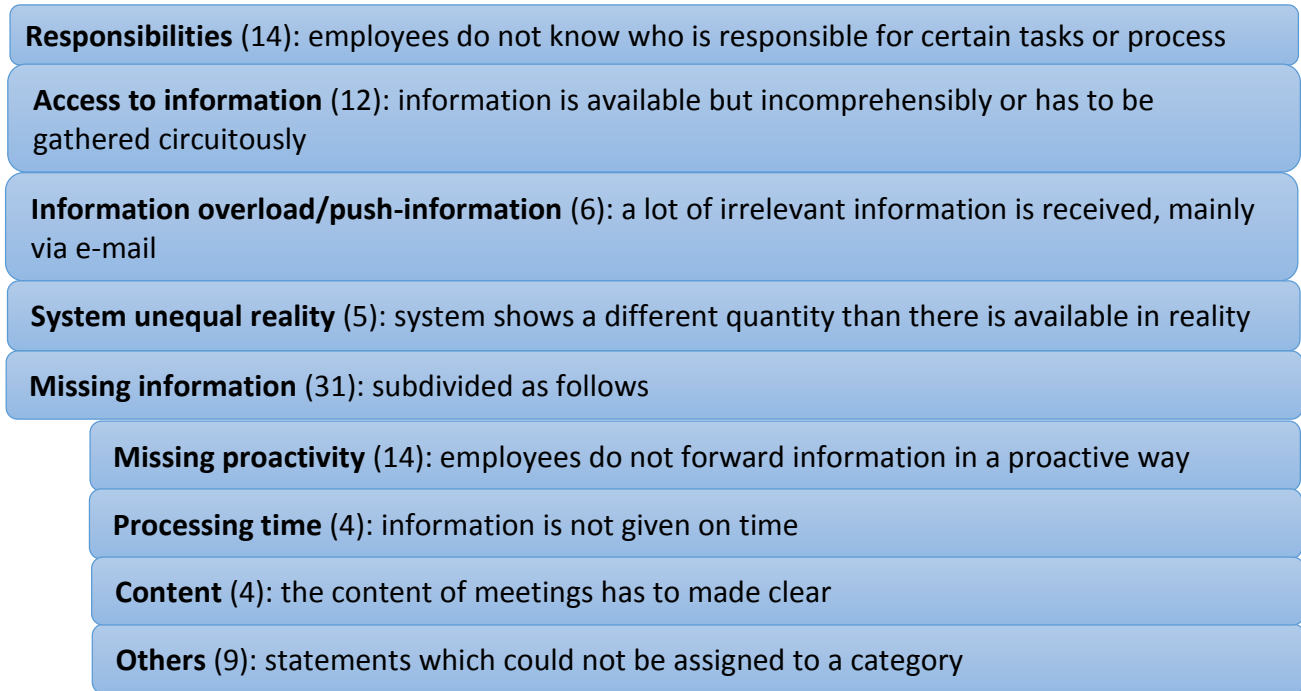


Figure 2: Overview of different categories (VOC-analysis)

Yet, the impact each statement has on process efficiency cannot be fully evaluated. For further analysis, a SIPOC diagram was used.

To get an insight in the relations between departments, the information flow model of Berger was used. It shows how information input is processed and how the information output serves as input for the next process step in the subsequent department. As recommended by Durugbo (2013), the standard information flow was visualized, analyzed and consequently found to be efficient. Almost no information duplication occurs – only at Production and Incoming Inspection the information is given both in form of paper and through the IT-system for a higher visibility. Information are mainly linked through the system SAP. Only when it comes to delays and deviations from the standard process, communication problems occur. To highlight the most relevant issues, process participants were asked to indicate the VOC-statement, which

bothers them most. By transferring these statements visually into the SIPOC diagram, and after consultation with the management team, four areas were found to be in need of action: 1) DCP, 2) the interfaces of Sales - Dispatch - MM, 3) Production Supply - Production, and 4) Incoming Inspection.

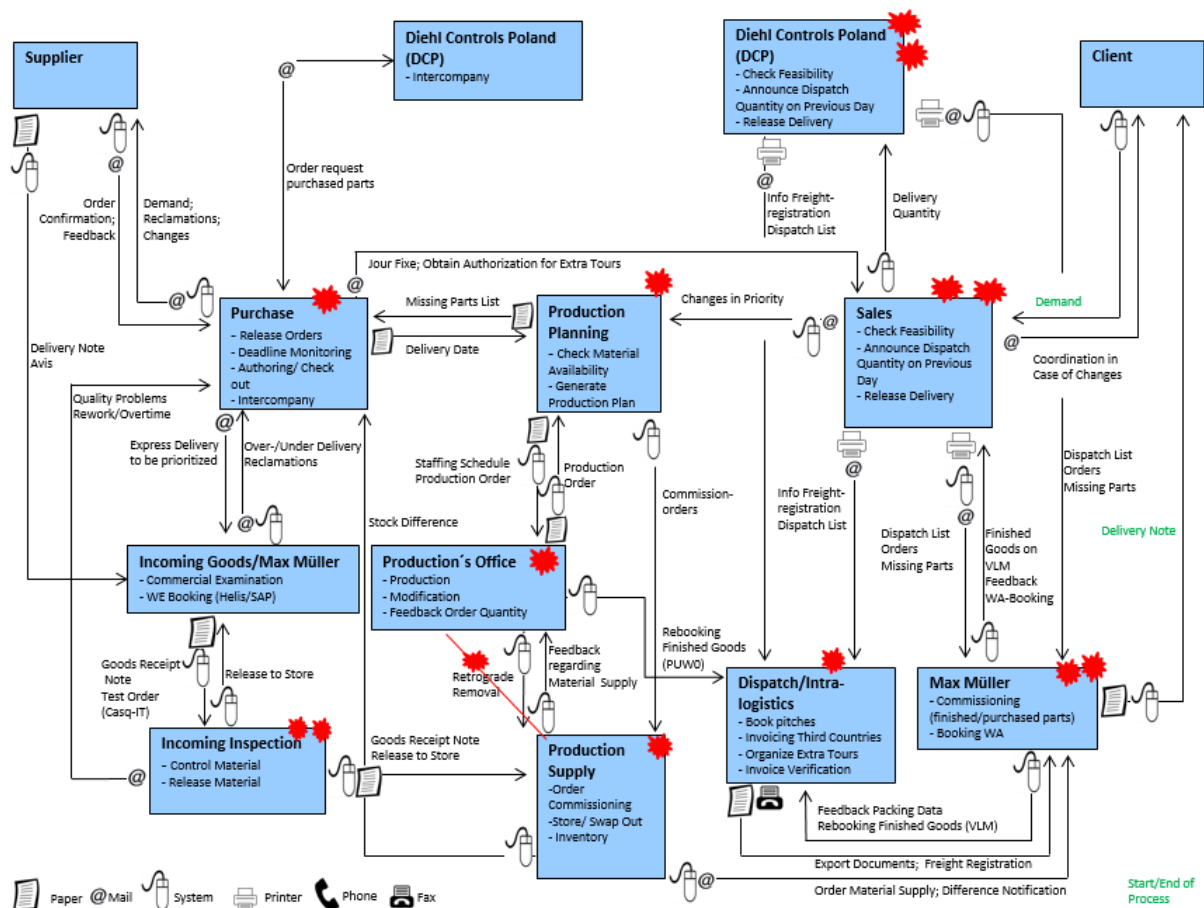


Figure 3: SIPOC with critical areas

The areas chosen are critical due to their relevance regarding a more flexible and efficient material flow. Additionally, they provide the possibility to improve several of the categories listed (see Fig. 2).

4.2. Measure-Phase

Before translating the associated problems of critical areas and interfaces into a measurable form, the problems will be explained.

DCP: A part of the finished goods at DCP are produced for clients of DCW, thus being managed and sold by DCW's sales employees. Therefore, the products concerned are sent from DCP to MM on a daily basis via a shuttle. Upon arrival at MM they are forwarded to the customer's location just as the finished goods produced in DCW.

Sales employees as well as customer supply managers criticized that the responsible employees at DCP do not contact them when there are delays and finished goods are not on the shuttle on the day planned. Moreover, they remark that they have to wait an unreasonably long time for a response when approaching DCP in a proactive way. Thus, finished goods which are already promised to the customers, do not arrive on time and customers cannot be informed in advance. This considerably dampens DCW's service level.

Sales - Dispatch - MM: Due to the close interconnection of the processes of the departments a strong communication effort is needed to ensure the timely deployment of finished goods at MM and the completion of required documents. They are picked up from MM's storage facility by different forwarders. Especially during high season, goods are often produced in the night shift before being collected in the morning. This explains the time pressure under which the departments work and the dependencies between them. A vast number of e-mails are sent between the departments each day with additional persons in copy. This is where duplication of information happens, leading to an information overload. Relevant information cannot be processed on time since a large number of redundant e-mails have to be checked as well. The level of visibility decreases considerably, since the guideline *relevant* information at the *right* place is not being followed. Furthermore, in some cases employees might not feel responsible, since colleagues received the same request.

Production Supply - Production: So-called kanban materials are needed for the majority of products and thus is automatically provided and refilled in the production halls. Order-related materials, in contrast, are required only for one specific order and are not provided

automatically. Therefore they have to be commissioned by Production Supply at the latest one day before production is planned. When providing order-related materials, a larger quantity is often delivered due to package sizes. After the order is fulfilled, Production frequently does not return the remaining materials to the warehouse. Hence, if the material is needed for a new order, it regularly happens that a sufficient quantity is not available in the warehouse, but in Production. While materials can be traced back to their exact storage space in the warehouse, this is not possible in Production. Thus, due to a lack of visibility the missing materials have to be searched, which is time-consuming and leads to unclear responsibilities: On the one hand, Production Supply is responsible for providing the material needed. Yet, Production is responsible for returning remaining material to the warehouse. However, since remaining material is not returned large stock differences occur. The consequence is that in some cases an order cannot be produced as planned or cannot be finished due to those shortfalls: Even though the system shows that a sufficient quantity is available, in reality it is not.

Incoming Inspection: Before being stored in the warehouse, raw material is checked by Incoming Inspection. One office is at MM where the majority of raw materials arrive before being transported to DCW. The second one is in Wangen. Raw materials that are urgently needed in Production have to be prioritized. Currently this is handled by Purchase or Production Planning, who inform Incoming Inspection via e-mail. Still these materials are occasionally stuck in Incoming Inspection.

As Becker states (see page 4), especially at interfaces time is lost, which leads to halting information- and material flows. Right now, those weak points are overcome by time-consuming, additional communication, preventing employees from working more efficiently.

The aim is to reduce the occurrence of problems at the presented weak points following the 80/20 rule of the Pareto principle: By eliminating 20% of the most prevalent causes, the overall

effects can be reduced by 80% (Brüggemann, 2012: 21). Measuring the weak points led to the following results:

DCP: Tally lists were distributed to employees in Sales, who are in close contact with the respective colleagues in Poland. They were asked to list arising problems and a short explanation over a period of two weeks. Even after extending the period to four weeks, only insufficient corresponding information was gathered due to low season. Thus, problems in other areas were prioritized.

Sales - Dispatch - MM: Both e-mail correspondence and phone traffic at the interfaces were measured with the following result: 189 e-mails were sent among the three departments within two weeks with a total of 413 people in copy. 63% of the e-mails were sent between Sales and Dispatch with 1.7 persons in copy on average. Especially mails coming from MM include a high number of persons in copy: More than three persons are informed additionally. When needing one minute on average to read an e-mail, one working day in two weeks is wasted in total, if 413 people read information that is not primarily relevant for them. Regarding phone traffic, the majority of phone calls (70% from a total of 204 calls) take place between Sales and Dispatch.

Production Supply - Production: By extracting data from SAP it was possible to measure where the materials of specific production orders were located when not available in the warehouse. The focus of the analysis was set on production hall eight. This is where most order-related materials are processed. 40 orders with a total of 243 materials – ranging from orders with one up to 17 materials – were examined. 63% of the materials were available at the warehouse. 22% were located in production hall eight. This means that almost every fifth order-related material had to be searched in Production, because it was not returned after having finished a previous order. While 1% of the materials needed was still locked in Incoming Inspection, 14% were at Max Müller. Even though the likelihood of MM delivering the missing material according to

the just in time-strategy is high, it is not guaranteed. MM does not prioritize materials without an according notice from DCW and materials requested from DCW after 2 pm cannot be considered and delivered on the same day.

Incoming Inspection: Since process participants were not able to gather sufficient information even within an extended period of time, the problem is not impacting the process to the high extent as assumed. As shown, only 1% of the materials was locked in Incoming Inspection.

Thus, the focus will be put on the interfaces between Production Supply and Production as well as Sales, Dispatch and MM, since their problems occur on a daily basis.

4.3. Analyze-Phase

The following analysis was carried out using the fishbone diagram. Therefore, process participants were consulted once again in order to understand the root causes step by step. Hereby, the statements made in the VOC-analysis were discussed as well. Afterwards, a validation with the management team took place. The causes are listed in descending order of importance.

Sales - Dispatch - MM: The overall issue is the short reaction time outbound logistics is given. Especially in high season time pressure is high, since some finished goods are already behind schedule due to delays from suppliers' side, for example. Due to misunderstandings and errors caused by time pressures, several of the following problems arise:

The main problem is informing all relevant process participants to ensure a smooth flow of materials, which are urgent and thus need to be prioritized, requires much effort. While Sales predominantly works with SAP, Dispatch barely works with the system, and MM does not use it at all, since its business model is based on another operating system. The root cause manifests in the media disruptions the departments are confronted with.

Media disruptions involve a high amount of e-mails as well. Many e-mails with information about materials, among others, are sent on a daily basis. Each sales employee at DWC and DCP (seven in total) sends an e-mail containing the number of pallets Dispatch has to announce to

forwarders so that they are picked up at MM the following day. Dispatch is informed as well – almost on a daily basis – whenever finished goods produced in Poland have to be reposted in SAP due to the triangular trade between DCP, DCW and clients. In addition to the high amount of e-mails each day, many persons for whom the information is not relevant in the first place are put in copy. On average, 1.5 colleagues are additionally informed about the announcement of pallets, for example. When MM sends information about freight registration to Dispatch once or twice a day, up to five persons receive a copy of the e-mail. This is due to unclarified responsibilities. Whenever the person in charge is not named, several persons are informed. The largest number of phone calls can be assigned to the exchange of information between Sales and Dispatch regarding special freights. The reasons for special freights are multifold: either clients request goods earlier than expected or there was a delay on DC's side.

The following problems do not arise on a daily basis. Upon occurrence, however, they are all the more problematic. Especially delays and standstills in Production lead to an inefficient material flow. In this case the notification process is insufficiently defined. Hence, problems escalate not until they arise in Sales when delivery is imminent. A proactive information transmission is not given and directly influences the service level of the company. The provision of finished goods at Dispatch is critical as well. In case finished goods are expected by forwarders the same day or when they are already waiting at MM, the goods need to be loaded on to the next shuttle. This, however, is sometimes not the case and finished goods are not loaded even though being awaited. The forklift driver is responsible for transportation of finished goods from Production to Dispatch. He works on a *go and see basis*. Therefore, Dispatch as well as forklift drivers need to be informed to prioritize certain goods. Right now, MM and Sales are involved in solving arising problems, even though not responsible (see VOC-analysis).

Sales regularly sends requests regarding inventory enquiry to MM. Due to media disruptions sales employees cannot get the information themselves. If quantities of pallets are changed upon customer requests after the announcement to Dispatch, an updated notice has to be sent.

Production Supply - Production: The root cause of order-related materials remaining in Production mainly is convenience:

Since the re-storage process of material has to be done manually and thus requires a lot of time, warehouse workers do not insist on production workers to return remaining materials. This goes along with the fact that order-related and kanban materials cannot be distinguished because they are provided in identical boxes.

Additionally, materials are not returned since they are often removed for repair work and from Quality department without being documented in the system. Even though there is a predefined process which the Quality department should follow, it is often not respected. Hence, stock differences occur.

If only a small quantity is left, the re-storage effort is considered too high, thus not undertaken. In some cases it would take a couple of minutes each time to dismantle and install equipment. In case the same material is needed for a follow-up order, the orders are often already commissioned together by Production Supply. Thus, on one hand, a return to warehouse is not possible and, on the other hand, is unnecessary. Nevertheless, it still remains a problem by creating stock differences and missing material.

In the following, measures for the elimination of root causes are introduced. In some cases, the benefit of an improvement does not surpass the effort, and is hence not considered.

4.4. Improve-Phase

As previously explained (see p. 4), visibility can be achieved both through better information provision regarding the system as well as through more effective communication among employees. This is why the following improvement measures aim at both factors in order to thoroughly enhance the information flow, thus increasing the level of supply chain visibility.

General approach: As elaborated in the theoretical part (see p. 5), a cross-departmental understanding among employees is often missing. By improving its network-oriented focus, DCW can increase visibility at interfaces and weak points. For reaching this aim, Basnet (2013) recommends job rotations, among others. Instead of moving employees to other departments permanently, as the term “job rotation” implies, a limited form on the operational level will be adapted. Employees will get the chance to accompany colleagues of related departments for one week to gain an understanding of upstream and downstream processes and interconnections. Their original position shall be perceived in a broader context to increase coordination and understand dependencies. Foresight is meant to be increased to manage the information flow more efficiently and proactively. Especially in case of issues like delays in the material flow, employees need to understand who is dependent on given information. Additionally, the active involvement of employees in an improvement process increases their motivation, as already explained in chapter 2.3. This way, sales employees, for example, will realize the consequences for Dispatch, when not notifying them regarding changed quantities of pallets (see VOC-analysis). As agreed on with the management team, and on the basis of the VOC-analysis, the round will first take place between the following departments, followed by further rotations between other departments:

- Sales - Dispatch
- Production Planning - Production Supply
- Purchase - Incoming Inspection

Even though the employee doing the rotation disturbs the process of the visited department when being present, the management team is convinced that the benefits gained by the program outweighs current disturbances.

Sales - Dispatch - MM: One project carried out simultaneously dealt with the short reaction times. The result was that Max Müller as well as Dispatch were informed the day before about the products and quantities that will be picked up. However, there is still time pressure, especially when goods are only finished the night before collection. Thus, the following measures were taken.

Media disruptions lead to inefficiencies and to a considerably high communication effort. Especially at interfaces, visibility is not guaranteed to an adequate extent. To compensate those blind spots, a significant communication effort between multiple departments and employees has to be carried out, involving many employees not affected by the prevailing issue. Therefore, monitors are being installed at central points to ensure that relevant information is automatically available at the right time at the right place in the right quality (Chibba/Rudquist 2004). Thus, visibility at interfaces is increased and risk is reduced (Schrottke et al., 2014: 3): The pace in which the company manages to collect all data and information needed to make the right decisions is improved (Linich 2014). Among other things, it helps that materials and finished goods can easily be prioritized at Max Müller and at DC without them having to be notified. The monitors provide information especially for employees, who do not continuously work on computers. The information shown on the monitors are accessible on normal computers as well. Besides four monitors at Sales, Dispatch, and Max Müller, three additional monitors are installed at Incoming Inspection and the warehouse. By doing so, the material flow is expected to become notably more efficient throughout the supply chain. To gather relevant information that facilitates daily work, statements of the VOC-analysis were considered and approved by process participants. Mainly, SAP transactions will be displayed on the monitors. Additionally,

a tool of Lotus Notes, which shows information regarding special freights, is needed. Lastly, an excel file was programmed, displaying urgently needed materials. By using the excel file, purchasers as well as production planners can enter urgently needed materials, which are consequently shown on the monitors at Max Müller, Incoming Inspection, and warehouse. The combination of these tools is the basis for ensuring a smoother material flow. For this purpose, currently e-mails are sent to an e-mail distribution list, causing the already mentioned soaring e-mail traffic. Through the monitors, numerous e-mails are replaced and only persons in charge get the information. A detailed overview of the information displayed on different monitors is given in Appendix 24. By providing monitors for increased visibility at interfaces, the VOC-categories “missing information/proactivity” as well as “information overload/push information” can be tackled.

As a second measure employees are meant to be sensitized by their line managers about whom to put in copy in an e-mail. Therefore, line managers were invited to a meeting with the supply chain director to show the severe consequences of putting irrelevant persons in copy.

Besides monitors, other improvements have a considerable impact as well. As shown in the measure phase, every day the responsible employee in Dispatch receives seven e-mails (with 1.5 persons in copy) of sales employees regarding the quantity of pallets that need to be announced to forwarders. Consequently all the information is manually transferred to a special document, which is sent to the relevant parties by fax. Now, one excel file replaces the e-mails. It is provided in the shared drive, so that sales employees can insert the information and quantities directly. Dispatch only has to print the file and send it to forwarders, which creates time savings and ensures that only the person in charge receives the information. By reducing the number of irrelevant e-mails, the level of visibility is increased, as envisioned by Holcomb (2011). Mainly the category “information overload/ push information” is positively affected by this measure.

To ensure a more targeted collection of finished goods in Production and its provision at Dispatch, SAP was installed on forklift terminals. By displaying a certain transaction, the warehouse worker in charge gets an overview of which goods are ready for pick-up at production lines. Especially before the arrival of MM's shuttle, the transaction can be used to see if finished goods can be picked up. By doing so, responsibilities are better defined, since Sales is not contacted in case of missing goods, as criticized in the VOC-analysis.

As elaborated by Hofman (2007: 13), a higher level of visibility and the access to relevant information prevents demotivation among employees, since time-consuming information procurement is decreased.

Production Supply - Production: Since it is not returned to warehouse, order-related material has to be searched in Production. As a root cause, convenience was identified due to a time-consuming re-storage process. “(T)o improve results, the best approach is to improve the process that gives you those results.” (Rever, n.a.: 1): This is why the process was redesigned in order to decrease the effort and ensure the re-storage of remaining material. Previously, the process of restoring materials was done manually by inserting each article number into a transaction of SAP, enter quantity in another, and search for an available storage place in a third transaction. Now, the re-storage is automatically carried out by the creation of a new transaction in SAP. Thus, a transport order can be created, which is consequently processed on a scanner (scanning the order number shows all related article numbers, quantities can easily be added, and a storage place is suggested). To standardize processes, the new return delivery process was implemented in DCP as well.

To support the return process a sticker will be attached to the boxes of order-related materials. This helps distinguishing kanban and order-related materials. Simultaneously, a different project is carried out, which remodels some of the processes at the warehouse, by setting up a repacking station. As soon as employees are familiar with the new process, attaching stickers

will become a part of it as well. The overall simplification outweighs the additional work of attaching a sticker. Thus, employee's resistance towards changes is assumed to decrease.

Due to the simplified process and distinction of materials warehouse workers will insist on Production to return materials in the future. Thereby, stock differences will be reduced. Even if additional material is used for repair work – upon return the quantity is checked and corrected in the system before storing. Thus, the system shows the quantities that are available in reality. Consequently, the communication effort regarding missing parts and the responsibilities for searching them are overcome. Moreover, besides remedying root causes, a secondary cause can be overcome as well: When returning materials to the warehouse, Quality and other departments cannot remove parts and have to follow the predefined process. There are, however, some cases in which material will still not be returned to the warehouse, since the effort would be too high. Especially if dismantling and installation takes several minutes, which is the case with SMD material.

4.5. Control-Phase

Sales - Dispatch - MM: After having implemented the file for the announcement of daily shipments the amount of e-mails was reduced. Based on the measures yet taken, until now, the number of e-mails would have decreased from 189 with 413 persons in copy to 149 with 353 persons in copy. Thus, by introducing one new file, the e-mail traffic was reduced by 21% and the number of employees who receive a copy decreased by 15%. Hence, the target value of 80% less communication effort was not reached. However, after the installation of the monitors and sensitization of employees – which did not happen at that time – the number is expected to decrease further.

Production Supply - Production: Before the redesign of the return process, 22% out of 243 materials were located in one of the production halls. After the process has been changed and employees started to attach stickers to distinguish the boxes, only 13% of order-related

materials had to be searched in Production. Thus, more than 40% of remaining materials are brought back to the warehouse by now. The number might even be higher, since only incomplete production orders were considered. It is safe to say that the number of orders, for which all materials were available at the warehouse, has increased as well, since the time to gather 40 production orders again was considerably longer than before changing the process. Moreover, a significant improvement can only be seen after an adequate period of time. Only after fully realizing the benefits of the new process, warehouse workers will insist on production workers to return the remaining materials.

5. Recommendations

Due to time constraints not every improvement activity was finalized, as listed below. It is essential, however, that these tasks are finished, since they were identified as being most critical to the quality of the process. Therefore, for the improvement measures to be successful, a person should be assigned responsible for ensuring their implementation and continuation.

Job rotation: Due to the current high season from September to December, job rotations are considered to be more effective when implemented at the end of January or beginning of February.

Installation of monitors: Monitors are ordered, central places for the attachment were identified, and the respective information are gathered. After having decided which tool to use to automatically update the presented information, they can be used.

Information on forklift: By displaying finished goods using an SAP transaction, a first step towards transparency was taken. However, there are tools that are more appropriate. Thus, a discussion of an investment in an alternative tool should be initiated.

The notification process in case of delays in Production has not been tackled yet. However, special attention should be devoted to that topic since it was found to be a root cause.

The communication with DCP remains challenging. Even though there was not sufficient data available to tackle the problem, numerous statements in the VOC-analysis illustrate the weak point. Thus, the information flow between DCW and DCP should be analyzed profoundly.

The analysis conducted at the interfaces of Sales, Dispatch, and Max Müller should be conducted for the inbound logistics as well (Purchase, Max Müller, and Incoming Inspection). By doing so, the communication effort can further be reduced and responsibilities defined to create a sustainable way to continuously reduce e-mail traffic and persons in copy. In the long term, current and future measures will help DC become a leader in the Aberdeen's Group by increasing its delivery performance up to 96% and a resulting better financial perspective.

6. Conclusion

The tools chosen to conduct the project did prove successful. The weak points most critical to achieve greater visibility in the supply chain were tackled and yet partly improved.

The reduction of e-mails and the sensitization of employees regarding the use of e-mails and copies ensures that relevant information can be read on time. By equipping forklifts with SAP, finished goods can be transported to Dispatch in a proactive manner. The new return process prevents major stock differences and guarantees the exact insight of where they are located. In the end, supply chain visibility was partly increased already by developing a more efficient information flow. The case study approach recommended by Eisenhardt helped introducing both strategic as well as operational solutions of how to increase supply chain visibility. Due to the partly high individuality of the solutions, they might not all be applicable for other companies. However, if the improvements did increase the overall flexibility and efficiency of the order-to-payment process cannot be answered in a satisfactory manner yet. It takes some time until the effect of improvements become visible and until now, not all improvements recommended were executed. Only in the long term it can be said if customer satisfaction will be increased by a better delivery performance due to a more flexible and efficient process.

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